Fire Management notes

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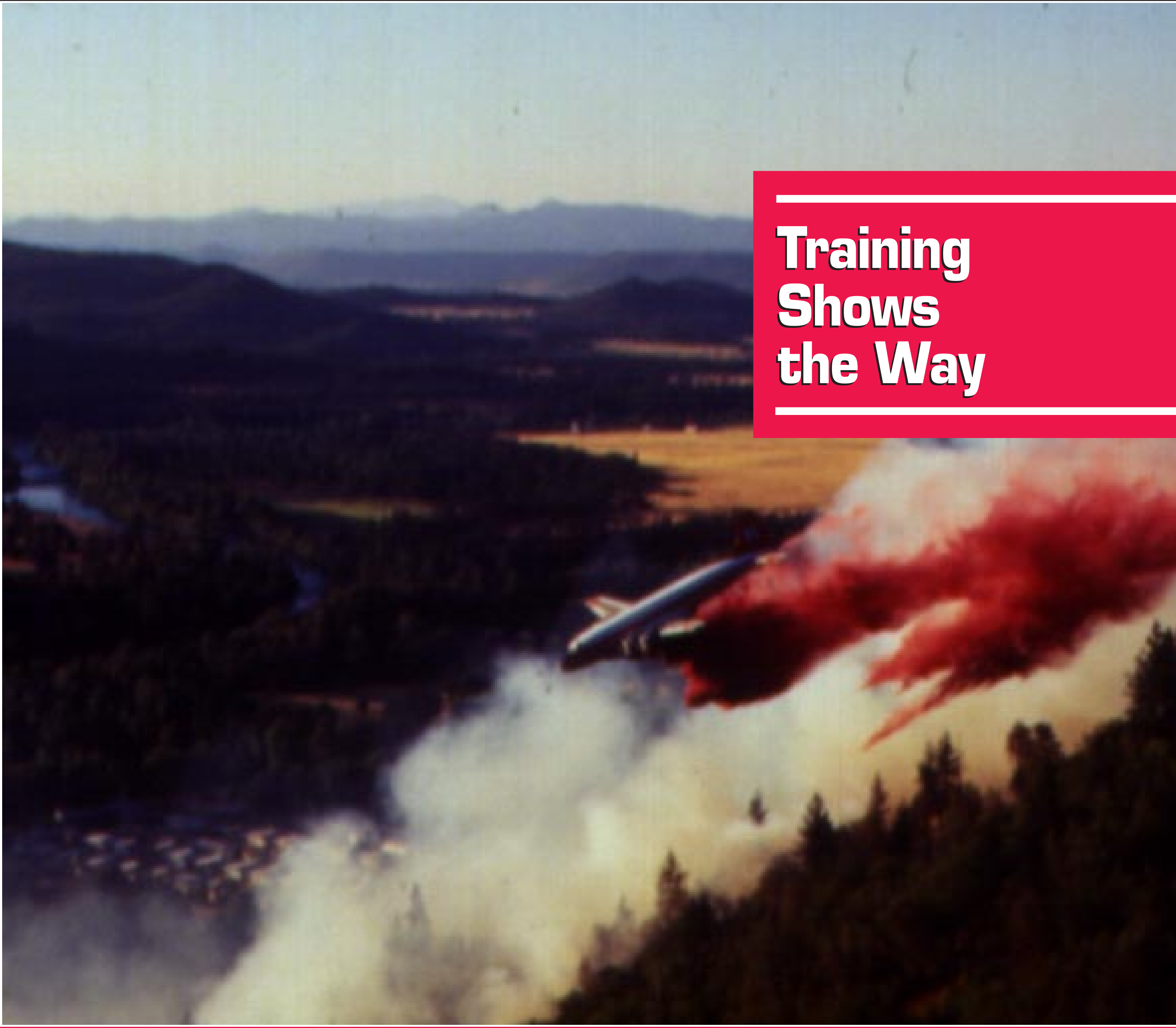

Training Shows the Way

United States Department of Agriculture
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On the Cover:

Whether training occurs in the air, in class, on the fireline, or at spike camp, it can help save lives, property, and natural resources (see related articles in this issue).

The cover photo of Airtanker 14 dropping retardant during the Indian Creek Fire on July 15, 1994, in southwestern Oregon was taken from one of three helicopters in mid-afternoon. Photo: Dan Thorpe, Oregon Department of Forestry, Southwest Oregon District, Central Point, OR, 1994.

Firefighter and public safety is our first priority.

U.S. Army Firefighters Practice "No Trace Camping" on Wilderness Wildfires

Francis Mohr and Karen Curtiss

"A U.S. Army Battalion has been assigned to your Park Meadow Fire and will be camped out in a nearby mountain meadow." Imagine yourself as the land manager responsible for the Three Sisters Wilderness on the Sisters Ranger District, Deschutes National Forest, in central Oregon where this wildfire was located. You've just heard that 300 firefighters plus logistical support personnel are about to move onto a pristine, high-elevation mountain meadow. The length of their stay is uncertain—it all depends on how long it will take to control the wildfire estimated at 700 acres (1,700 ha). It could be a few days or much longer.

Your first concerns are the existing and potential fire behavior along with the possibility of excessive resource damage caused by a large number of people within the confines of a fragile, sensitive area. Evidence of wilderness resource damages from past wildfire suppression, sometimes caused by only one or two crews (20 to 40 people), is still visible today in many wilderness areas. As the responsible manager, you know you must ask, "What is the potential for resource damage when 300-plus firefighters are involved? What can we do to protect the environment?"

Francis Mohr is a fire management consultant in Baker City, OR, and Karen Curtiss is the assistant fire staff officer for the Deschutes National Forest, Bend, OR.

> "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."—Aldo Leopold, *A Sand County Almanac.*

Background of the Park Meadow Incident

The Park Meadow Fire was one of 30 wildfires initiated by a thunderstorm that passed over central Oregon on the late afternoon of August 23, 1996. The lightning strike occurred in a narrow mixed-conifer stand of older mountain hemlock, lodgepole pine, Englemann spruce, subalpine fir, and white fir. The visual characteristics of such a stand were:

- A dense tree crown canopy with interspersed dead branches, needles, and moss stringing down 1 to 2 feet (0.4 to 0.8 cm),
- A continuous vertical arrangement of fuels provided by branches of the mixed species composition, with all ages present,
- Some clumps of dense understory intermingled with dead standing trees due to natural competition for soil, water, and minerals, and
- Fuels at the ground surface consisting of a light layer of branches and needles and, occasionally, a partially decomposed, fallen tree.

After being exposed to a week of high temperatures, low relative humidities, and consequent low fuel moisture content, this fuel situation was very receptive for the lightning spark to start a fire. (The Lightning Detection System recorded 31 strikes, of which 30 developed into wildfires in this area during this period.) The Haines Index (Haines 1988)—an indicator of existing atmospheric stability—was at "6," the extreme end of the index curve. All these phenomena coincided within the same 24-hour period. Even for this high-elevation, coniferous stand—often called "asbestos" during a majority of the fire seasons—the stage was set for easy ignition, a rapid increase of fire intensity, development of a heat convection column, and fire behavior that soon dominated its own environment. Within the first burning period, an estimated 550 acres (1,360 ha)—even on level to gently sloped ground—burned intensely. Several spot fires dotted the fire periphery. Similar atmospheric conditions existed the following day, although the resulting fire behavior was not as dramatic. The estimated size after the first two burning periods was about 700 acres (1,700 ha), with potential for more before fire suppression efforts could be effective.

The thunderstorm that initiated these wildfires in central Oregon continued its path across northeastern Oregon and into Idaho. More wildfires developed, resulting in a need for fire suppression forces. The U.S. Army 4th Engineer Battalion from Fort Carson, CO, which was just being released from fire suppression activity in northern California, was quickly reassigned to assist with the central Oregon wildfires.

District Resource Advisors' Response

For Paul Engstrom and Kirk Metzger, district wilderness rangers working as resource advisors on the Mt. Jefferson Wilderness Fire since early July, the arrival of the Army battalion added to an already overloaded work schedule. Two additional "spike camp" situations were already being developed on two other adjacent mountain meadows. Fire lining was occurring on different portions of the fire perimeter, and the resource advisors were concerned that the use of MIST (Minimum Impact Suppression Tactics) would not be implemented by some crews unfamiliar with the concept and wilderness resource. Dave Priest, another Sisters District employee, and Kent Koeller, a wilderness ranger for the adjacent Bend Ranger District, were called to assist with the work load. Shortly thereafter, Bob Vidourek from the USDI Bureau of Land Management arrived.

The five resource advisors acted quickly and soon decided on the following set of procedures and instructions to be used consistently with the crews and supporting personnel arriving at the wildfire site:

- Camping and storage of supplies will be in the tree-covered area, away from the grassy area of the meadow.
- Sleeping areas, the camp kitchen, latrines, and storage of supplies will be restricted to designated areas within the adjacent tree stands.
- The first choice for these designated areas will be previously used, impacted sites. (Through the "Limits of Acceptable Change" planning process, the District knew where and how many such sites existed within the vicinity of these meadows.)
- No open fires or establishment of "fire rings" will be permitted.
- Only obvious "hazard trees" within the sleeping and camp kitchen areas will be cut and removed.
- Crews will use just one route across the meadow or will restrict their travel to the fringes in the moist, boggy portions. Travel across any live stream within the meadow will be at predetermined places only. (Such routes were marked by red flagging.)
- All designated areas within the tree stands will be rehabilitated to "as natural appearing a landscape as possible." Crews will complete rehabilitation before they are demobilized from the fire site.
- Foot travel to the latrine and sleeping areas will be on one path rather than several. (White flagging marked the selected route so that it was easily visible at night.)
- Portable latrines, similar to the ones used with back-country river float trips, will be used, although the slit-trench method may be necessary until these arrive.

The resource advisors stayed at the three "spike camp" sites. They also spent time along the fire perimeter, promoting, explaining, and demonstrating the use of MIST during the fire lining and mopup activities. The fire crews were at the fire site for 5 days. The only deviation from the procedures and instructions outlined above occurred during a heavy rain shower over the fire area early one evening. Most crews were able to retreat to their sleeping tents or under tent canopies used in the camp kitchen area before the rain hit. However, some crews from one spike camp had not yet returned from the fire site and were entirely soaked. To avoid possible hypothermia, four large fire rings were made, and branch wood from dead, standing trees was used for the warming fire. Even in this situation, no cutting was permitted. To leave an appearance more closely resembling a naturally occurring event, the dead branches were broken off. In addition, to protect the soil, fires were built on the top of old fire shelters.

Although the procedures and instructions outlined by the resource advisors sounded "strange" compared to what traditionally occurred during previous wildfire situations, the fire crews were receptive and made the attempt to follow them. As might be expected, some firefighters interpreted these instructions differently from the resource advisors' interpretation. Therefore,

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additional followup and explanations were necessary on a case-by-case basis. Some rehabilitation techniques were necessary, but for the most part, fire crews attempted to follow the outlined procedures and instructions, thus greatly reducing the amount of suppression impacts and need for excessive rehabilitation activities.

This was not the first time district employees were challenged with the concern of potential resource damage from wildfire suppression activity. Earlier in the summer, there was a wildfire in the Mt. Jefferson Wilderness, also administered by the Sisters Ranger District. The promotion of MIST and "Leave No Trace Camping" was the management direction for this wildfire as well. The resource advisors mentioned earlier and Mike Riehle, a fisheries biologist, responded to the call. In addition, Tom Smith, a recreation facilities supervisor, traveled between two spike camps, ensuring that fire crews understood and practiced the instructions provided by the resource advisors.

They Made It Happen

A postfire, onsite review of the spike camp areas revealed that "No Trace Camping" is not just an expected set of human behaviors reserved for wilderness and backcountry recreationists or users. It can and should be the only accepted human behavior during wildfire suppression as well—especially in our more sensitive and fragile managed areas such as wilderness and national parks. (See figures 1 and 2 for scenes of the spike camp where "No Trace Camping" was followed.)

> "Witnessing the results that occurred on these wilderness wildfires is rewarding and a move in the right direction toward better land ethics and stewardship."

Figure 1—*The Army tent areas (the crews' sleeping quarters) during the Park Meadow Fire were restricted to designated areas that had often been previously used. Photo: Kirk Metzger, USDA Forest Service, Deschutes National Forest, Sisters, OR, 1996.*

Figure 2—*The Army tent area for the Park Meadow Fire (shown in fig. 1) after rehabilitation. Photo: Kirk Metzger, USDA Forest Service, Deschutes National Forest, Sisters, OR, 1996.*

Four hundred sixty firefighters and supporting personnel were assigned to the three spike camps on the Park Meadow incident. In addition, 300 others were involved with the two spike camps and suppression effort on the Mt. Jefferson incident. These firefighters (U.S. Army 4th Engineer Battalion and the other fire crews) deserve a word of recognition and gratitude for their cooperation. Without their willingness to make the effort, long-term adverse impacts on the land and damage of the wilderness resource would have resulted.

Management emphasis by Karen Shimamoto, the district ranger, toward the concept and implementation of MIST helped provide the overall land management and consequent fire suppression direction to the Incident Management Team and firefighters. Such support is critical for those assigned to serve the role of resource advisor.

There would be no story to tell without the dedication of the resource advisors assigned to these wilderness incidents. (See figures 3 and 4.) They prevailed in what might have seemed like an enormous task to achieve. Perhaps their very basic approach should be established as a set of principles or "commandments" for those who are asked to fill the role of resource advisor for wildfires in the future. Briefly, the resource advisors:

Figure 3—*A portion of the fireline during the Park Meadow Fire in central Oregon in 1996. Photo: Kirk Metzger, USDA Forest Service, Deschutes National Forest, Sisters, OR, 1996.*

Figure 4—*After the Park Meadow Fire, crews restored the portion of fireline shown in figure 3 to "as natural appearing a landscape as possible." Photo: Kirk Metzger, USDA Forest Service, Deschutes National Forest, Sisters, OR, 1996.*

- Explained what the wilderness resource is, the intent of the Wilderness Act, and the experience it could bring to each visitor;
- Explained why the actions and conduct of humans, even during such an emotional and aggressive event as a wildfire, need to coincide with the intent of wilderness resource;
- Explained what actions could be performed to accomplish the job of suppressing the fire, yet protecting wilderness values;
- Repeated their explanations, the "why's" and "how's," not just at formal morning or evening briefings, but with the crews while back at camp or with any interested firefighter on the line; and
- Did it themselves. Their own behavior set the example they expected of others. They stayed at the spike camps until the crews left and demanded nothing better than what was available for the firefighters.

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In addition, these resource advisors were experienced in fire incidents, having served either on crews or as a strike team leader. Certainly, this factor added to their credibility and acceptance with the firefighters and crews. When selecting individuals to serve as resource advisors for their unit or agency, managers should look for such experience.

Summary

Witnessing the results (figs. 3 and 4) that occurred on these wilderness wildfires is rewarding and a move in the right direction toward better land ethics and stewardship. There is no doubt that one of the earlier patriarchs and promoters for increased land ethics and stewardship—Aldo Leopold—would have been proud of the Sisters Ranger District, resource advisors, and firefighters involved. In his *Sand County Almanac* (1949), Leopold states:

"A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."

These folks did what was right. It may not have been popular, however. It was not what traditionally occurs in wildfire situations. But in the end, the suppression job was achieved, and the integrity of the resource was not sacrificed.

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Guidelines for Contributors

Editorial Policy

Fire Management Notes (*FMN*) is an international quarterly magazine for the wildland fire community. *FMN* welcomes unsolicited manuscripts from readers on any subject related to fire management. (See the subject index of the first issue of each volume for a list of topics covered in the past.)

Because space is a consideration, long manuscripts are subject to publication delay and editorial cutting; *FMN* **does** print short pieces of interest to readers.

Submission Guidelines

Authors are asked to type or word-process their articles on white paper (double-spaced) on one side. Try to keep titles concise and descriptive; subheadings and bulleted material are useful and help readability. As a general rule of clear writing, use the active voice (e.g., write, "Fire managers know . . ." **and not** "It is known . . .").

Submit articles to either the general manager or the editor. They can be reached at the following:

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Firefighter Crews Need Unit SOP*

Kent Lewis

When the smokejumpers held a reunion in Missoula, MT, in July of 1995, the keynote speaker was Secretary Bruce Babbitt of the Department of the Interior. Secretary Babbitt's message was that we have apparently learned nothing in the 45 years between the Mann Gulch and South Canyon Fires. He called for a complete reevaluation of all that we do in firefighting. Near the end of his presentation, he said that we need to look outside our organizations. We need to use the resources and experience of others—perhaps seek the advice of the Army's Command and General Staff College.

> Simulated wildfires (prescribed burns) are opportunities to conduct unit training exercises—firefighters' "war games." Such training would help develop Unit SOP's and "create a source of intact, trained units for wildfire assignments."

I took special note of Secretary Babbitt's comments. I had read the newspaper accounts of the South Canyon incident, and like many old jumpers and firefighters, my reaction had been, "How could a disaster like that happen?" I called Bill Ward at the National Interagency Fire Center in Boise and asked for copies of any investigative reports on the incident. He provided me with the *Report of the South Canyon Fire Accident Investigation Team* and the *Final Report of the Interagency Management Review Team: South Canyon Fire.*

Kent Lewis was a hotshot crewman and smokejumper for the USDA Forest Service in the 1960's. Following a tour as a Vietnam-era Army officer, he pursued a career in real estate. He returned to firefighting in 1996, working for the season on the fire crew at Red River District, Nez Perce National Forest, Elk City, ID.

**This article appeared, in part, as "Unit Standard Operating Procedure—A Must for Crews" in the November 1997 issue of* Wildfire.

Training Differences

There are obvious differences between the way the military prepares for and commits to missions and the way wildland firefighters do it. The military trains individuals, forms these people into units, and then trains the units in large-scale exercises known as war games. When committing to missions, the military tends to commit units that have leadership intact.

Wildland firefighters have nothing so formal as war games, and as a usual practice, they bring people together to form units at the time a mission exists. In particular, there is less concern for maintaining unit integrity at the middle levels of command. Division people and strike team leaders are assigned on the spot, not having been part of either the Fire Management Teams under which they serve nor part of the crews they supervise. I theorized that this lack of unit "completeness" could have a disastrous effect on unit communications that would ultimately lead to fatalities.

To test my premise, I sought out two active-duty Army officers. I asked them to listen to and comment on the following scenario.

Consider This "Worst-Case" Scenario

You have been assigned to command a mission. This mission is time critical. Decisions you make must be workable the first time. Lives will be at stake. The mission will involve high stress—both physical and mental. You will command a hierarchical organization of highly trained and experienced people from a variety of locations and agencies assembled for this particular mission.

This scenario, familiar to wildland firefighters, was less than ordinary for Army officers. One of them asked, "Have these people worked together before?"

"No," I said, "in fact, many of these people have never met before being assembled for this mission."

His gut-instinct reaction was, "The mission is doomed to failure!" When the other officer agreed, I asked why.

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The first officer said, "There is no Unit SOP!" He felt that a Unit Standard Operating Procedure is critical to the success of the mission; without it, the mission would be predisposed to failure.

Firefighters do rely on Standard Operating Procedures (SOP's) to ensure that certain actions are undertaken. (The "10 Standard Fire Orders," for example, are mandates ordering a set of actions.) However, the firefighting community fails to emphasize the importance of Unit SOP's—the unique ways that individuals perform tasks to accomplish the goals of the unit.

Unit SOP: A Device for Communicating

Unit SOP facilitates communications within a unit. Orders can be issued that are not complete in every detail, yet recipients carry them out by relying on Unit SOP—the way things are "always done" in that unit. Members of the unit have the luxury of knowing the intentions beyond what is spoken or written. People can predict what others will do in a given set of circumstances. Unit SOP is a level of communication that is very relative to unit experience, and it functions even in the absence of detailed, well-formed directives. As a communications device, Unit SOP is incredibly efficient and necessary for a crew to be fully prepared to perform under a worst-case scenario, where stress and time constraints would otherwise affect performance.

"Unit SOP is incredibly efficient and necessary for a crew to be fully prepared to perform under a worst-case scenario, where stress and time constraints would otherwise affect performance."

On the fireline in 1996, a crew leader keyed his radio and said to his squad leader: "Bump on up here!" That could have meant, "Come up here," or "Bring your squad up here"—in the sense of fireline-construction lingo. Needless to say, the order was less than clear and less than complete.

However, the squad leader reacted as expected by his supervisor. Apparently, he instantaneously evaluated the order, made a decision, and performed an action—relying on prior experience with similar communications within the unit. The crew leader and the squad leader were able to communicate efficiently (using only four words), each relying on Unit SOP to facilitate and supplement communications.

Firefighters recognize the important role of communications. It's the second element of L.C.E.S. (Lookouts, **Communications**, Escape Routes, and Safety Zones). Yet, when firefighting crews are assembled "on the fly," communications within units are compromised.

Where people have worked together over time, Unit SOP develops as an efficient way to get the right things done. Most of it isn't written down; it's simply understood by the members of the unit and works to the advantage of supervisors in accomplishing the mission. For example, several years ago, I was part of a six-man smokejumper crew. One of the jumpers cut his finger. He and I had served on prior fires together, so he asked if I still had a stash of bandages in my wallet (a habit of mine since my days in the blister rust program). I fixed him up, and 20 percent of the line crew went back to work in less than a minute. We solved the problem, and our leader was never involved. Was Unit SOP at work? You might say so. Apparently, a very small part of Unit SOP was that, "Lewis has a stash of bandages." We relied on the standard, and the leader was not distracted by a minor detail.

Unit SOP and Safety

Because the worst-case scenario rarely develops, we tend to be less than fully prepared to deal with it. We usually attack, mop up, and go home. Our good luck prevails, so our ability to deal with the "worst case" is rarely tested.

We do, however, train individuals to deal with worst cases. For example, the "Standards for Survival" course improves the safety margin for individuals. Unfortunately, we fail to require the worst-case training for units. Through that failure, we miss the opportunity for units to develop Unit SOP's, and thereby newly formed units are not fully prepared to deal with worst-case scenarios.

War Games: Firefighter-style

For several reasons, including fuel build up in our wildlands, wildfires are more dangerous than they used to be. We absolutely must prepare

Supervisors, the SOP Can Work for You

Our firefighting force is accordion-style; it expands when needed and contracts when the rains come. Because of current budget constraints that imply reduced training and loss of talent through early retirement, many of our firefighters are temporary and don't have "institutional memory." We simply don't have years to develop Unit SOP's.

Fortunately, Unit SOP has a life of its own. It's born the moment a unit is formed. As members come together and begin interacting, the SOP begins to form. It develops, evolving while the unit remains active. You, the supervisor, couldn't stop it even if you wanted to. However, you can and will influence it. Through your leadership, you direct the way things are "always done" (the Unit SOP). And, if you are watching for it, the speed with which a good, usable Unit SOP is constituted will surprise you.

Turn each project or detail, no matter how trivial, into an opportunity for the SOP to develop. Plan your order (who, what, when, where, why, and how). Issue that order to your immediate subordinates only. Require that they supervise their subordinates. Soon, you will be able to issue concise orders, telling your people simply "**what** to do." The military reduces orders to "what," allowing ingenuity and Unit SOP to fill in the details. Similarly, you and your subordinates will be able to rely on unit experiences to fill in the particulars. Remember that you want proficiency and consistency to become habits for the unit.

Initially, the formality of proper orders for trivial tasks may seem unnecessary and burdensome—a little like stirring coffee with a baseball bat. However, if your methods are casual, then unit performance will be casual. Such performance would never meet the demands of the worst-case scenario.

As a supervisor with attendant increased responsibilities, you must prepare personally to perform—especially in the worst-case scenario. Let Unit SOP help you. Think of it as a collection of 10,000 solutions to challenges that will be handled automatically by your crew. It's your key to successful unit performance.

As Unit SOP develops, you'll notice several anomalies. First, a sort of compensator seems to operate to accomplish whatever goals you have set. While you may issue an order for a specific person to do a specific task, others will help that person or assume tasks to free him or her up. The accomplishment of the assigned task comes out of more than the individual effort of the assigned person. It comes out of people compensating for and helping each other. When you see compensation begin to happen, take a break. Enjoy the moment. Something great is happening. Your people are developing Unit SOP.

With increases in unit performance, you'll see pride in the unit begin to develop. Unfortunately, the "Can Do" attitude was maligned in the South Canyon Fire investigation. Yet esprit de corps delivers that extra ounce of energy to the unit and to each member of the unit. When it exists, individual efforts go up. More work gets done with higher attention to details, including safety. People get revitalized by the extra ounce of energy and perform better even under the most adverse conditions and circumstances. You cannot afford to ignore the source of that energy. Promote it instead. Make Unit SOP work for you.

our crews to meet the challenge of these fires. Training opportunities arise from the increased use of prescribed fire. We should staff these simulated wildfires with intact command structures and with training specialists to observe, evaluate, and critique individual and unit performance. The training exercises—our own "war games"—would provide for the development of Unit SOP's and create a source of intact, trained units for wildfire assignments.

Watch Out! No Unit SOP

Some units operate like well-oiled machines. Some hotshot crews and some district crews are notable examples. Class I and Class II Management Teams are trained as units and committed with leadership intact. The effectiveness of these units is a direct product of unit experience and well-developed Unit SOP's. However, we are still prone to folly. We regularly do things that should raise "Watch Out!" concerns about their effect on communications and safety. As we respond to fire missions, we owe it to ourselves to take special note of situations such as the following:

- A supervisor knows only three of the crew members,
- Jumpers from five different bases are assembled on a mountain top with a contingency of hotshots detached from their regular crew to form a new crew,
- The crew leader is not assigned by a higher authority but seems to assume command after the crew is actually on the fire, and
- The intact chain of command did not exist before the current mission.

Actions and situations such as the above tend to compromise Unit SOP. Communication suffers, and the actions result in reduced margins of safety. However, we can expect major returns when we invest in unit training coupled with full consideration of the importance of unit integrity and Unit SOP. The payback is proficiency and safety. We are all interested in these dividends.

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Firefighter Safety Zones: How Big Is Big Enough?

Bret W. Butler and Jack D. Cohen

All wildland firefighters working on or near the fireline must be able to identify a safety zone. Furthermore, they need to know how "big" is "big enough."

Beighley (1995) defined a safety zone as "an area distinguished by characteristics that provide freedom from danger, risk, or injury." The National Wildfire Coordinating Group proposed that a safety zone be defined as "a preplanned area of sufficient size and suitable location that is expected to prevent injury to fire personnel from known hazards without using fire shelters" (USDA/USDI 1995).

In our study of wildland firefighter safety zones, we focused on radiant heating only. In "real" wildland fires, convective energy transport in the form of gusts, fire whirls, or turbulence could contribute significantly to the total energy received by a firefighter. However, convection is subject to buoyant forces and turbulent mixing, both of which suggest that convective heating is important only when a firefighter is relatively close to the fire. One reason that firefighters in potential entrapment situations are told to lie face down on the ground is to minimize their exposure to convective heating. We hope to define more clearly the relationship between convective heating and safety zone size in future work.

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> A safety zone should be large enough so that the distance between the firefighters and flames is at least four times the maximum flame height.

What Do We Know?

Two questions are important when specifying safety zone size: 1) What is the radiant energy distribution in front of a flame? and 2) How much heat can humans endure before injury occurs? Concerning the first question, Fogarty (1996) and Tassios and Packham (1984) related the energy received by a firefighter to fireline intensity and distance from the flame front. Green and Schimke (1971) presented very specific information about fuel break construction on slopes and ridges in the Sierra Nevada mixed-conifer forest type. Others have discussed the performance of fire shelters under different heating regimes (for example, King and Walker 1964; Jukkala and Putnam 1986; Knight 1988). As one would expect, there is not much information related to the second question. The available information suggests that 0.2 Btu/ft^2/s (2.3 kW/m^2) is the upper limit that can be sustained without injury for a short time (Stoll and Greene 1959; Behnke 1982). Studies by Braun and others (1980) suggest that when a single layer of 6.3 oz/yd^2 (210 g/m^2) Nomex cloth is worn, second degree burns will occur after 90 seconds when a firefighter is subjected to radiant fluxes greater than 0.6 Btu/ft^2/s (7 kW/m^2).

The Nomex shirts and trousers currently used by wildland firefighters have fabric weights of 5.7 and 8.5 oz/yd^2 (190 and 280 g/m^2), respectively. Few studies, however, have explored relationships between flame height and the safety zone size necessary to prevent burn injury.

Theory Versus Reality

We formulated a theoretical model to predict the net radiant energy arriving at the firefighter wearing Nomex clothing as a function of flame height and distance from the flame (Butler and Cohen [In press]). Figure 1 displays the results.

The amount of radiant energy arriving at the firefighter depends both on the distance between the firefighter and the flame and on the flame height. The information shown suggests that in most cases safety zones must be relatively large to prevent burn injury.

We compared safety zone sizes predicted by our model against those reported on four wildfires: the

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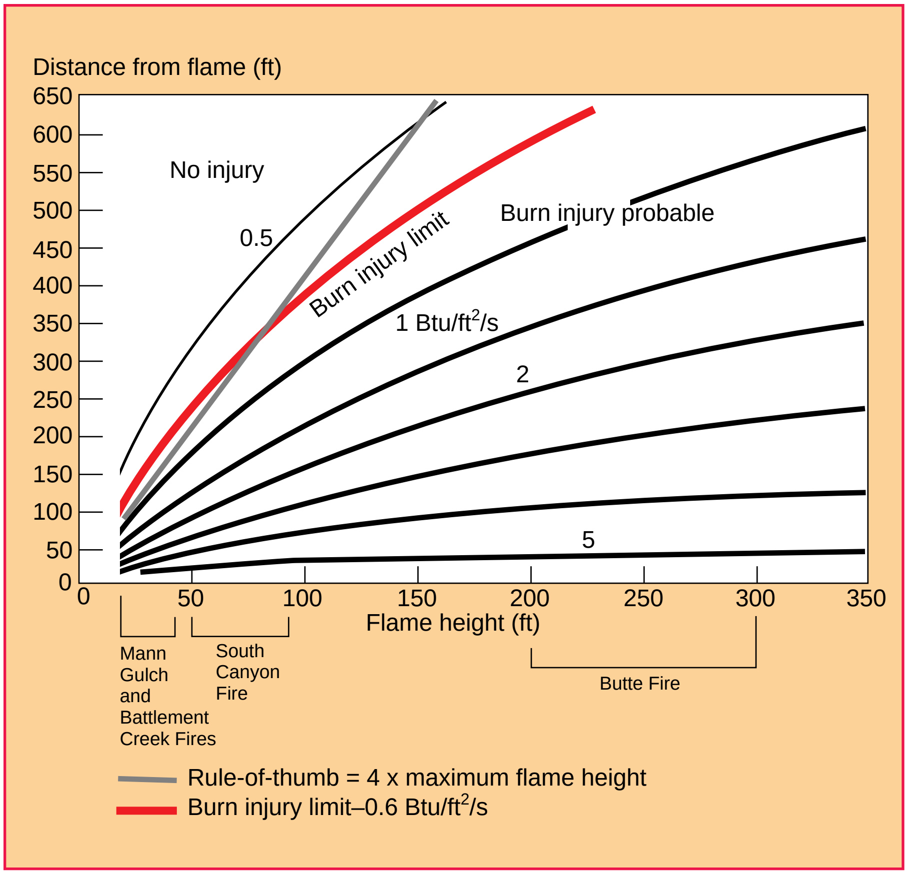

Figure 1—*Lines represent predicted radiant energy arriving at the firefighter as a function of flame height and distance from the flame. It is assumed that the firefighter is wearing fire-retardant clothing and protective head and neck equipment. The heavy shaded line represents the burn injury threshold of 0.6 Btu/ft²/s (7 kW/m²). The heavy solid black line indicates the rule of thumb for the size of the safety zone.*

Mann Gulch Fire, the Battlement Creek Fire, the Butte Fire, and the South Canyon Fire.

The Mann Gulch Fire overran 16 firefighters on August 5, 1949. Wag Dodge, one of only three survivors, lit a fire and then lay face down in the burned-out area as the main fire burned around him. The Mann Gulch Fire occurred in an open stand of scattered, mature ponderosa pine (60 to 100+ years old) with a grass understory. Flame heights of 10 to 40 feet (3 to 12 m) were estimated to have occurred at the time of entrapment. Rothermel (1993) indicates that Dodge's fire burned about 300 feet (92 m) before the main fire overran it. Assuming an elliptical shape for the burned area, with its width approximately half the length, the safety zone created by Dodge's escaped fire would have been about 150 feet (46 m) wide. Figure 1 indicates that the safety zone needed to be large enough to separate the firefighters and flames by 90 to 150 feet (27 to 46 m) or approximately the same width as the area created by Dodge's fire.

The Battlement Creek Fire occurred in western Colorado during July of 1976 (USDI 1976). The fire burned on steep slopes covered with 6- to 12-foot- (2- to 4-m-) high Gambel oak. Flames were estimated at 20 to 30 feet (6 to 9 m) above the canopy. Four firefighters were cut off from their designated safety zone. When the fire overran them, they were lying face down on the ground without fire shelters in a 25-foot- (8-m-) wide clearing near the top of a ridge. Tragically, only one of the four survived, and he suffered severe burns over most of his body. Figure 1 suggests that for this fire, the safety zone should have been large enough to separate firefighters from flames by 150 feet (46 m). Clearly, the 25-foot- (8-m-) wide clearing did not qualify as a safety zone.

Flame heights were reported to be 200 to 300 feet (62 to 92 m) high on the Butte Fire that burned on steep slopes covered with mature lodgepole pine and Douglas-fir during August of 1985 (Mutch and Rothermel 1986). Figure 1 indicates that a cleared area greater than 1,200 feet (370 m) across would have been needed to prevent injury to the firefighters standing in its center. In fact, safety zones 300 to 400 feet (92 to 123 m) in diameter were prepared (Mutch and Rothermel 1986). This diameter was not sufficiently large enough to meet the definition of a safety zone, as indicated by the fact that 73 firefighters had to deploy in fire shelters to escape the radiant heat. As the fire burned around the edges of the deployment zone, the intense heat forced the firefighters to crawl while inside their shelters to the opposite side of the clearing.

On July 2, 1994, the South Canyon Fire was ignited by a lightning strike to a ridgetop in western Colorado. During the afternoon of July 6, the South Canyon Fire "blew up," burning across the predominately Gambel-oak-covered slopes with 50- to 90-foot- (15- to 28-m-) tall flames (South Canyon

Fire Accident Investigation Team 1994). Tragically, 14 firefighters were overrun by the fire and died while attempting to deploy their fire shelters. Twelve of the firefighters died along a 10- to 12-foot- (3- to 4-m-) wide fireline on a 55-percent slope, the other two in a steep narrow gully. Eight other firefighters deployed their fire shelters in a burned out area approximately 150 feet (46 m) wide. They remained in their shelters during three separate crown fire runs that occurred 450 feet (138 m) away from them; none of these eight firefighters was injured (Petrilli 1996). One firefighter estimates that air temperatures inside the shelters reached 115 °F (46 °C) and remembers smoke and glowing embers entering the fire shelters during the crown fire runs. Survivors felt they were far enough from the flames that survival with minor injuries would have been possible without the protection of a fire shelter (Petrilli 1996). A firefighter who did not deploy in a shelter but remained on a narrow ridge below the eight firefighters during the "blowup" experienced no injuries (South Canyon Fire Accident Investigation Team 1994). Figure 1 suggests that in this situation, the safety zone must be large enough to separate the firefighters and flames by 250 to 350 feet (77 to 115 m).

A general rule of thumb can be derived from figure 1 by approximating the injury limit with a straight line. After doing so, it appears that a safety zone should be large enough that the distance between the firefighters and flames is at least four times the maximum flame height. In some instances—such as the Mann Gulch, Battlement Creek, and Butte fires—the fire may burn completely around the safety zone. In such fires, the separation distance suggested in figure 1 is the radius of the safety zone, meaning the safety zone diameter should be twice the value indicated.

What About Fire Shelters?

We calculated the net radiant energy transferred through a fire shelter like those used by firefighters in the USDA Forest Service. The fire shelter is based on the concept that the surface will reflect the majority of the incoming radiant energy. An average emissivity for the aluminum-foil exterior of a fire shelter is 0.07, indicating that approximately 93 percent of the energy incident on a fire shelter is reflected away (Putnam 1991). Model predictions shown in figure 2 suggest that heat levels remain below the injury limits for deployment zones wider than 50 feet (15 m), even with 300-foot- (92-m-) tall flames. However, this model does not account for convective heating that could significantly increase the total energy transfer to shelters deployed within a few flame lengths of the fire.

Conclusions

Radiant energy travels in the same form as visible light, that is, in the line of sight. Therefore, locating safety zones in areas that minimize firefighters' exposure to flames will reduce the required safety zone size. For example, topographical features that act as radiative shields are the lee side of rocky outcroppings, ridges and the tops of ridges, or peaks containing little or no flammable vegetation. Safety zone size is proportional to flame height. Therefore, any feature or action that reduces flame height will have a corresponding effect on the required safety zone size. Some examples are burnout operations that leave large "black" areas, thinning operations that reduce fuel

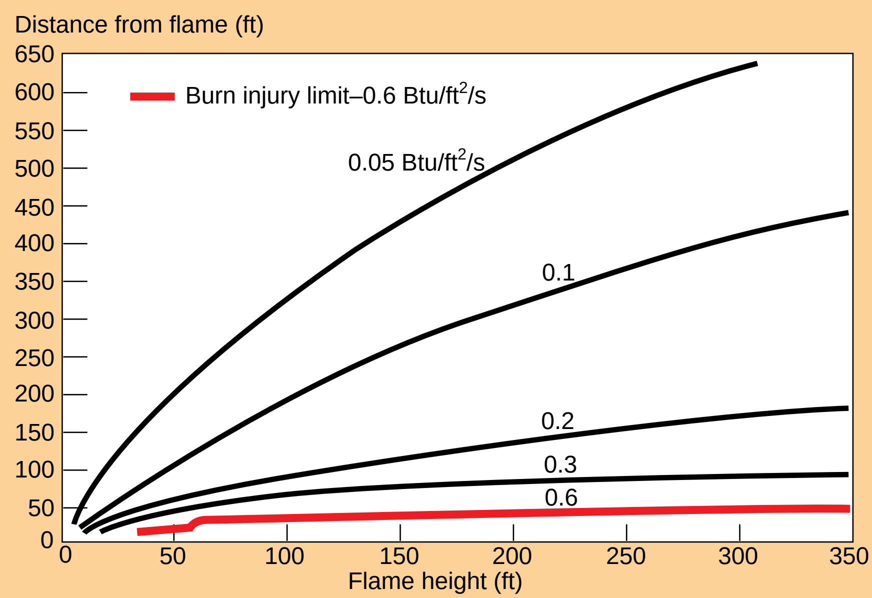

Figure 2—*Predicted radiant energy on a fire shelter as a function of distance between the fire shelter and flames, and flame height. The heavy shaded line represents the burn injury threshold for a firefighter inside a deployed fire shelter.*

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load, and retardant drops that decrease flame temperatures.

We emphasize that while this study addresses the effects of radiant energy transfer, convection is not addressed. Convective energy transfer from gusts, fire whirls, or turbulence could significantly increase the total heat transfer to the firefighter and thus the required safety zone size. Further work in this area is needed.

Acknowledgments

The United States Department of the Interior's Fire Coordinating Committee, Boise, ID, provided financial assistance for a portion of this study. Ted Putnam of the Forest Service's Missoula Technology and Development Center, Missoula, MT, provided valuable information and advice on the effects of heat on human tissue.

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THE NARTC SHOWS YOU THE FUTURE

April J. Baily and Tara Megan Chambers

The National Advanced Resource Technology Center (NARTC) in Marana, AZ, provides training not only for personnel in wildland management agencies in the United States, but also to many others from around the world. NARTC, administered by the USDA Forest Service's Fire and Aviation Staff in Washington, DC, is dedicated to advancing global technology transfer and meeting current and future resource management needs. The 14-member, service-oriented staff is responsible for planning and producing lesson materials. The goal of these professionals is to show the way into the 21st century.

Location and Activities

Marana is located in Pinal County at Pinal Air Park, just 30 miles (48 km) northwest of Tucson. The informal, campus-like setting of NARTC is surrounded by 2,000 acres (810 ha) of the Sonoran Desert. The climate is mild and conducive to outdoor activities such as jogging and bicycling. An Olympic-size, outdoor swimming pool and an exercise room are available to students at no charge.

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National Advanced Resource Technology Center provides training for wildland management agencies throughout the world.

Catalog of Courses

The courses and instructors are continually evaluated to ensure the most knowledgable and competent instruction. Students must be nominated to attend classes and often have to be put on a waiting list. The following courses were offered recently or will be taught soon (many courses are offered on a biyearly basis) and offer an excellent sample of what is available.

National Park and Wilderness Fire Management
For: Wilderness and fire program managers who plan, implement, and manage fire programs in Federal parks and wildernesses.

This course includes the philosophy, policies, program planning, and implementation of prescribed fire programs, available technology, and fire suppression strategies of the wilderness and national parks.

The National Advanced Resource Technology Center (NARTC) logo welcomes students to the classroom complex (in the background). Photo: Dee Williams, National Advanced Research Technology Center, Marana, AZ, 1997.

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Senior Level Aviation Management
For: Senior managers of aviation programs.

With an opportunity for interaction among Federal and non-Federal aviation programs, this course identifies many issues of aviation program management, such as government regulation, safety programs, methods for attaining program integrity and accountability, and methods used to successfully integrate aviation personnel in natural resource programs.

S-520 Advanced Incident Management
For: Incident commanders, safety officers, or general staff members of a national Interagency Type I incident management position.

Team composition for this course includes an incident commander; planning, operations, logistics, and finance section chiefs; and a safety officer. They work under complex simulated fire situations.

S-620 Area Command
For: Those persons in wildland fire agencies who are available to participate on a National Interagency Area Command Team, are functionally qualified under an Incident Command System (ICS) at the Type I level, and who have completed S-520.

The team composition of area commander, area commander planning chief, area command logistics chief, and command aviation coordinator will learn to act effectively under a simulated multifire [incident] situation, using the principles and concepts of "area command."

Interagency faculty and students participate in an exercise during "Fire in Ecosystem Management." The course looks at the historic, current, and future roles of fire in ecosystems and explores social, political, legal, and economic factors that influence the integration of fire into the management of ecosystems. In the foreground (aqua shirt) is course steering member and instructor Meredith Weltmer, USDI Fish and Wildlife Service. Photo: Dee Williams, National Advanced Resource Technology Center, Marana, AZ, 1997.

Aerial Retardant Application and Use
For: Incident commanders, fire suppression program leaders, section chiefs, division group supervisors, air tactical group supervisors, air support group supervisors, airtanker coordinators, and air operations branch directors.

Through lectures, case studies, discussions, and exercises, participants learn about the retardant delivery system; environmental considerations in the use of aerial fire retardants; safety, decision-making, and systems management; and operational use of retardants.

Fire Management Leadership
For: Administrators in the USDA Forest Service at the forest supervisor and deputy forest supervisor levels, the USDI National Park Service and Bureau of Indian Affairs at the superintendent level, the USDI Bureau of Land Management Agency at the district manager level, and USDI Fish and Wildlife Service at the resource manager level.

With emphasis on overall understanding of fire management, this comprehensive course looks at the agency administrators' leadership roles and ability to manage complex fires effectively, and clarifies policy, authority, and responsibility affecting the administrator.

Fire in Ecosystem Management
For: Agency administrators, natural resource specialists and managers, cultural resource specialists and managers, ecosystem managers and coordinators, fire specialists and managers, land management planners, research scientists, and public affairs specialists and coordinators.

Participants are exposed to a variety of programs that integrate the historical, ecological, and socioeconomic aspects of fire management into ecosystem management.

Interagency Aviation Management and Safety (IAMS)
For: Full-time and collateral duty managers who have aviation management and coordination duties at regional or State levels but lack strong aviation backgrounds.

Prerequisites are project inspector experience for resource or land management agency aviation projects or responsibility for primary or collateral aviation programs. IAMS gives participants the information needed to manage safe and effective aviation programs and emphasizes administration, safety, operations, and program monitoring.

FARSITE Fire Growth Simulation
For: Graduates of S-590 or RX-590 currently working as Fire Behavior Analysts (FBAN's) or prescribed fire behavior analysts (RXFA's) who are proficient with fire behavior prediction models.

Participants must have taken S-490 (Advanced Wildland Fire Behavior Calculations) and have experience with BEHAVE and data input and retrieval on Windows using an IBM or IBM-compatible computer. This course describes applications of FARSITE as well as teaches individuals how to input data into the program, run the fire growth model, and interpret outputs. Participants in the course will have their names placed on a list of FARSITE "super-users."

D-510 Supervisory Dispatcher
For: Individuals who have previous training and experience at the support dispatcher level and will supervise an expanded dispatch organization.

Prerequisites include Basic ICS 1-200, D-310 Support Dispatcher, S-401 Advanced Supervision, (S-401) Effective Management (or equivalent), Interagency Aviation Management and Safety (IAMS), and S-290 Intermediate Fire Behavior. Problem-solving exercises and scenarios help trainees learn to develop and manage a dispatch organization.

RX-540 Applied Fire Effects
For: Fire management officers, prescribed fire program managers and practitioners, resource management specialists, and Type I and Type II burn bosses.

Participants must have taken RX-340 (Introduction to Fire Effects), have qualification as a Type II burn boss, or have equivalent training and experience. Course objectives are divided into four units: "Determine Ecological and Cultural Perspective," "Appraising Treatment Strategies," "Selecting and Implementing Treatment Strategies," and "Monitoring, Evaluating, and Adaptive Management."

National Fire-Danger Rating System (NFDRS)
For: Individuals who will become NFDRS instructors, individuals who are responsible for fire protection resource decisions based on outputs from NFDRS park level, BLM district level, or State protection area level; and those responsible for operating and processing data for NFDRS.

This course gives trainees the technical skills needed to teach regionally sponsored courses for wildland fire agencies using NFDRS.

Long-Term Fire Risk Assessment
For: Anyone being trained as a prescribed fire behavior analyst who wants to gain knowledge in long-term fire assessment.

Trainees must have completed S-490 (Advanced Wildfire Behavior Calculations). The course includes analytical techniques to evaluate risks associated with fire movement and smoke impacts, emphasizing managing wildfires that last a long time.

Please contact Director John Roberts for more information on the NARTC's courses, instructors, nomination process, or prerequisites at National Advanced Resource Technology Center; Pinal Air Park, Marana, AZ 85653, or telephone 520-670-6414. ■

Reduce Fire Hazards in Ponderosa Pine by Thinning

Joe Scott

Forest stands of fire-dependent ponderosa pine cover about 40 million acres (16 million ha) in the Western United States. Ponderosa pine is commonly found in pure stands on dry sites, but in more moist conditions, it is associated with Douglas-fir, lodgepole pine, western larch, and others. Historically, these were often widely spaced stands of large pines with an undergrowth of grasses and forbs. This structure was maintained by frequent surface fires that reduced invading tree species, rejuvenated the understory vegetation, and created a seedbed suitable for ponderosa pine regeneration. Today, by contrast, pine stands are dense, closed-canopy stands, often with thickets of small trees in their understories. As a result, these forests are experiencing insect and disease epidemics and severe wildfires.

Much residential and recreational development exists in the ponderosa pine forest type because many people regard this low forest type as very aesthetically pleasing. Unfortunately, most years these forests become quite flammable during warm, dry summer months. In the last century, wildfires were characteristically of low intensity and severity because they occurred relatively often. However, fires in this type today are likely to be much more severe for a number of reasons:

- Unmanaged ponderosa pine forests often have heavy accumulations of dead and down fuels as a result of decades of accumulation without "cleansing," low-intensity surface fires. These heavy fuels lead to higher fire intensities and increase fire-caused mortality to trees.
- Today's dense forests are more tightly packed with trees, leading to an increased risk of torching and crown fires.
- The establishment of an understory of small trees presents a "ladder" that allows a fire to climb from the surface into the crowns of overstory trees.
- Torching trees and crown fires are a significant source of firebrands that cause fire suppression problems. Firebrands are considered to be a major source for ignition of wildland homes.

Thinning treatments in ponderosa pine were developed to reduce fire hazard and maintain the high aesthetic values of the forest while emphasizing either minimum impact, revenue production, or forest restoration.

Fire managers know that fire hazards in ponderosa pine stands can be lessened by prescribed burning and by thinning trees to lessen the likelihood of a crown fire. Such treatments generally reduce the potential surface fire intensity and keep the fire from spreading into tree crowns. Hazard-reduction treatments such as thinning and prescribed burning have been designed and implemented largely for commercial forest land, where aesthetic concerns are fewer and occur at a different scale (far view as opposed to near view) than for residential and recreational areas. The public is often wary of efforts to apply hazard reduction treatments, especially thinning, to high-value recreational areas. Private landowners also seem to be concerned about applying such treatments on their own residential forest land. Since there are few precedents for applying hazard-reduction treatments in residential and recreational settings, it is difficult to gain the public support necessary to successfully implement such treatments.

The USDA Forest Service's Intermountain Fire Sciences Lab collaborated with the University of Montana School of Forestry and the Ninemile Ranger District of the

Joe Scott is currently a research forester with Systems for Environmental Management and is the proprietor of Residential Forest Management, Missoula, MT. He conducted this cooperative research as a graduate student at the University of Montana.

Lolo National Forest to demonstrate three hazard reduction thinning and burning treatments. All treatments were designed to reduce fire hazard and improve forest health. The cost and revenue of conducting the treatments, changes in fuel loading by component, and public perception of aesthetics were compared for each of the three treatments. Following is a summary of the initial results of this demonstration.

Study Area

The study area is located in the Ninemile Ranger District, about 30 miles (48 km) west of Missoula, MT. The area is covered by a dense stand of second-growth ponderosa pine and Douglas-fir, with Douglas-fir constituting a minority of the total basal area. The stand originated after the logging of the late 19th century, with most trees in the stand about 100 years old. A study in this area indicated fire intervals were historically very short, averaging 8 years prior to 1900. No fires have burned in this stand since its establishment.

The study area is at 4,000 feet (1,219 m) elevation, with slopes generally south-facing at 5 to 15 percent. The average diameter is approximately 8 inches (20 cm) for both ponderosa pine and Douglas-fir. The maximum tree diameter is 23 inches (58 cm) for both ponderosa pine and Douglas-fir. Understory vegetation is composed mainly of grasses (dominated by pinegrass), shrubs such as snowberry, kinnikinnick, ninebark, and serviceberry, and Douglas-fir regeneration.

Methods

Four rectangular 6-acre (2.4-ha) treatment units were established within the study area, three for treatments and one for a control. Sample points were established in each unit to measure stand structure and surface fuels before and after treatment. Three thinning treatments to reduce fire hazard were developed with a second objective of improving forest health while maintaining the high aesthetic values of the forest. Details of the treatments follow:

Treatment 1: Minimum Impact. This treatment was designed to be so low in impacts that it would be acceptable to most of the public. The stand was lightly thinned by removing the smallest, least healthy trees and those with low-hanging live crowns. The density of the stand was reduced by about 30 percent to 100 ft^2/acre (23 m^2/ha) of basal area. The cut trees were made into small sawlogs, pulpwood, and firewood. The total sawlog harvest volume was 1.7 thousand board feet per acre (MBF/acre) (9.9 m^3/ha). Logs were skidded using a 50-horsepower (37 kW) farm tractor. The slash from cutting these was piled by hand and burned after drying for one summer. In addition to the logging slash, small Douglas-fir trees (ladder fuels) and existing dead and down fuels were also burned in these hand-built piles.

Treatment 2: Revenue Production. This treatment was designed for application on a wide variety of private and public lands where producing short-term income and reducing fire hazard are desired. The density of the stand was reduced by 50 percent by harvesting all sizes of trees. This treatment produced pulp logs and medium sawlogs. Conventional mechanized logging equipment (feller-buncher, grapple skidder, and mechanical delimber) was used for this whole-tree skidding operation. Total harvest volume was 5.2 MBF/acre (30.3 m^3/ha), much higher than Treatment 1. Slash was piled at a landing and burned after drying over the summer.

Treatment 3: Forest Restoration. In addition to reducing fire hazards, this treatment was designed to restore natural conditions and improve forest health. The density was reduced by 50 percent by cutting the smallest, weakest trees. This treatment produced pulp logs and medium sawlogs. The total harvest volume was 3.6 MBF/acre (21.0 m^3/ha), intermediate between Treatments 1 and 2. The harvest method was the same as Treatment 2, except that some of the slash was "backhauled" by the skidder and spread back in the stand to allow recycling of the nutrients in the slash. The unit was broadcast-burned in the fall under a mild prescription after the slash had dried for one summer.

Treatment units were remeasured after two growing seasons of recovery. The net revenue of each treatment was determined by subtracting the logging and other treatment costs (burning and hand-piling) from the gross revenue expected for current log prices (as of December 1995).

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Visual quality was evaluated for the three treatment units and two control units. While one control was the untreated unit, the second was a nearby unthinned stand that was burned severely in a prescribed fire, then salvaged for firewood and sawlogs. Visual quality was compared using Triad analysis in which viewers were shown 10 sets of three photos and asked to identify which they liked the most and which the least. Data for 28 viewers were tabulated to reveal if any preference among the treatments existed.

Results

Table 1 shows the changes in fuel loading by component for each of the treatments. Treatment 1 (Minimum Impact) showed a lower total fuel load than before treatment because the fuel components most important to fire spread and intensity (herbaceous, needle litter, and 1-hour timelag fuels) were reduced. Small trees (ladder fuels) were nearly eliminated, and the overstory was thinned enough to prevent the spread of a crown fire, but the fuel bed is still well-shaded and sheltered from wind so the fire hazard is low.

Treatment 2 (Revenue Production) showed a slight increase in total fuel load, although litter and 1-hr fuels were both reduced. While herbaceous material increased in response to the increased light and water available, it represents a very small fraction of the total fuel load. The data indicate that duff increased and

A forest unit in the study area 2 years after the "Minimum Impact" treatment was used; this treatment was ranked as having the "highest aesthetic quality." Photo: Joe Scott, Missoula, MT, 1995.

Two years after the "Forest Restoration" treatment, this unit is the most capable of resisting wildland fires. Photo: Joe Scott, Missoula, MT, 1995.

Treatment 2—"Revenue Production"—reduced the stand density by 50 percent; this treatment yielded more short-term income than the other treatments. Photo: Joe Scott, Missoula, MT, 1995.

The untreated control unit, 2 years after the other units were treated as described in this article. Photo: Joe Scott, Missoula, MT, 1995.

Table 1—*Fuel loading (tons/acre) by component for each of the treatment units in the study area. Post-treatment measurements were made 2 years after treatment.*

	Unit 1 Minimum Impact			Unit 2 Revenue Production			Unit 3 Forest Restoration			Unit 4 Untreated
Component	**Pre-treatment**	**Post-treatment**	**Change in %**	**Pre-treatment**	**Post-treatment**	**Change in %**	**Pre-treatment**	**Post-treatment**	**Change in %**	
Herbaceous	.19	.17	-10.5	.22	.26	18.2	.31	.37	19.4	.10
Needle litter	1.25	1.11	-11.2	1.18	.95	-19.5	1.18	.69	-41.5	1.16
1-hr	.23	.17	-26.1	.42	.19	-56.0	.41	.06	-86.5	.27
10-hr	.89	1.19	34.6	1.13	2.23	97.3	1.53	.98	-36.1	.92
100-hr	1.02	1.31	28.5	1.46	1.02	-30.0	1.03	1.46	41.8	.58
1,000-hr sound	5.32	1.64	-69.2	4.03	.80	-80.1	6.15	4.69	-23.8	3.76
1,000-hr rotten	1.67	.69	-58.8	1.49	.89	-40.1	2.77	.33	-88.1	3.49
Duff	17.1	18.2	6.2	15.9	21.3	34.3	17.7	15	-15.4	17.7
Small trees	.11	.02	-81.8	.11	.05	-54.5	.07	0	-100	.09
Total	27.76	24.45	-11.9	25.93	27.72	6.9	31.15	23.54	-24.4	28.06

1,000-hr fuels decreased, though these materials were not directly handled in the treatment. The coarse (especially rotten) material may have been crushed enough by the heavy logging equipment to be considered as duff in the remeasurement. The overstory in this treatment is quite open, making a crown fire impossible and torching unlikely.

Treatment 3 (Forest Restoration) showed the greatest reduction of fuels. All components except 100-hr and herbaceous fuels were reduced. Herbaceous fuels increased in response to the increased light, water, and nutrients available after burning and thinning. The fall broadcast burn effectively reduced the load of duff, needle litter, small trees, and fine fuels. Crown scorch from the burn also raised the live crown base, making a crown fire extremely unlikely, especially given the reduced surface fuels.

The estimated net revenue from these treatments is shown in table 2. Not surprisingly, Treatment 2 produced the most revenue of the three, at $1,067 per acre ($2,637/ha) treated. Treatment 3 produced $459 per acre ($1,134/ha) treated. The high cost of the prescribed burn—$267 per acre ($659/ha)—is due to the season of burn and the small burn unit used here. Spring burning on larger units could increase the net revenue of this treatment to nearly $600 per acre ($1,483/ha). Treatment 1 produced the smallest net revenue, due to the relatively expensive logging method and the small harvest volume per acre. The cost of handpile burning the slash and other fuels amounted to $77 per acre ($190/ha) in this treatment, but would increase if the harvest volume were higher.

The Triad method of comparing visual quality ranks the five "conditions" based on the total point count of all scenes and all viewers. A photo that a viewer selects as the "most preferred" of the Triad set receives two points, since it is preferred over two other scenes. The least preferred receives no points, and the intermediate gets one point. Twenty-eight observers ranked the five treatments by total point count as follows:

Treatment	Total point count
Treatment 1 (Minimum Impact)	384
Treatment 2 (Revenue Production)	345
Treatment 4 (Unburned Control)	332
Treatment 3 (Forest Restoration)	317
Treatment 5 (Burned Control)	302

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Table 2—*Net revenue per acre (and per ha) from the different treatments. Delivered log value was determined from the prices of individual species and the average species mix from all treatments.*

Unit	Harvest volume in MBF/acre (m^3/ha)	Delivered log value in $/MBF ($/m^3)	Logging cost stump to mill in $/MBF ($/m^3)	Additional treatments in $/acre ($/ha)	Net revenue in $/acre ($/ha)
1	1.7 (9.9)	$404 ($171)	$215 (91.1)	$77 ($190)	$246 ($608)
2	5.2 (30.3)		$200 ($84.8)	$3.33 ($8.23)	$1,067 ($2.637)
3	3.6 (21.0)		$200 $84.8)	$267 ($659)	$459 $1,134)
4	0		N/A*	N/A*	$0

*Not Applicable

By this analysis, Treatment 1 was ranked as having the highest aesthetic quality, whereas Treatment 5, the severely burned and then salvaged logged area, was ranked the lowest. However, the relatively low spread in point count indicates that there appears to be strong similarity among treatments. The severely burned area probably scored even higher than it should have, because in the photos it was difficult to tell that most of the trees were dead. In just a few years, these dead trees will fall down, further reducing the aesthetic quality.

Conclusion

This project demonstrated several alternative thinning methods to reduce forest fire hazard and improve forest health in aesthetically sensitive residential and recreational forests. All of the treatments implemented in this study appear to be appropriate for reducing fire hazards in a sensitive and cost-effective manner. Although the treatments are quite similar in design and implementation, there are differences among them, both significant and subtle, that make them appropriate in different situations.

Treatment 1: Minimum Impact. This treatment is highly favored for its aesthetic quality and is preferred over not only the other treatments, but over the untreated stand as well. The treatment was moderately effective in reducing fire hazard by reducing fine fuels, raising the live crown base, removing ladder fuels, and spacing tree crowns. Although this treatment produced significantly less net income than the others (table 2), it nonetheless more than paid for itself, providing a return of $246 per acre ($608 per ha) to the landowner. This treatment is favored on small private residential properties where aesthetic values are high. The Forest Service may find such a treatment useful in areas with very high recreational values and significant public concern over harvesting.

Possible changes to this treatment include a lower residual stand density, perhaps of about 85 square feet per acre (20 m^2 per ha), if the thinning is still done from below, leaving the largest, healthiest trees. The aesthetic acceptance of this treatment is probably derived from the nature of the thinning (from below) and from the low-impact logging and slash disposal methods. A broadcast burn could probably be implemented in this treatment without significant degradation of aesthetic quality if it is conducted after the slash fuels have been reduced by pile-burning. A burn conducted in slash fuels would likely result in too much bark char and mortality for aesthetic acceptance.

Treatment 2: Revenue Production. This treatment, appropriate on a wide range of public and private land, was certainly effective at providing income. It produced more income than the other treatments (table 2), was effective at reducing the fire hazard by thinning the overstory, and ranked high aesthetically.

There is little that could be changed in this treatment to improve its effectiveness. Additional slash treatments such as a broadcast burn could not be justified in light of the income-producing emphasis. Mechanized logging equipment should consistently provide the most cost-effective harvesting in this forest type. Any further reduction in basal area would probably produce an unacceptable aesthetic condition, especially since the thinning is from above. Care must be exercised when implementing a high thinning to avoid "high grading." The goal of a high thinning is to leave a high-quality stand of trees by thinning in the dominant and codominant crown classes.

Treatment 3: Forest Restoration. This appears to represent a middle-ground treatment that balances aesthetics, income production, and forest health—truly an "ecosystem management" treatment with broad application. Any treatment that couples a low thinning with a broadcast burn should reduce wildfire hazards; the data show that this treatment was the most effective in reducing fire hazard. Even with the high cost of the broadcast burn, this treatment showed a modest return per acre. Unfortunately, aesthetic quality suffers whenever a broadcast burn chars the boles of trees. This type of thinning and burning treatment in the pine type has broad applicability on public lands and increasingly on private lands.

Some changes could be made to improve this treatment. In this implementation, slash was back-hauled from the landing and spread with the grapple skidder to retain as much of the nutrient base on the forest floor as possible. While this practice may have long-term benefits for forest productivity, when coupled with a prescribed burn, the increased fuel loads lead to increased mortality, bark char, and crown scorch, with negative implications for aesthetics. It may be preferable to dispose of the slash in a landing pile and broadcast burn the "natural" fuel bed with the small amount of additional slash left after a fully mechanized logging operation. The residual basal area could probably also be reduced slightly, bringing in more income and perhaps helping to create more "natural" conditions, without adversely affecting stand aesthetics.

For more information, contact the Rocky Mountain Research Station for a forthcoming publication that contains further details on this research.

Acknowledgment

This research was supported in part by funds provided by the USDA Forest Service, Rocky Mountain Research Station, Missoula, MT. ■

Mountain Driving Video Now Available

Dick Mangan

"Driving Mountain Roads—Slowing Down," a new video from the USDA Forest Service's Missoula Technology and Development Center (MTDC), is now available to wildland fire service employees and coordinators. The Safety and Fire programs at MTDC developed the video, which highlights the dangers of driving on mountain roads, to help reduce accidents that result in personal injury and property damage. The 20-minute video can be used as a stand-alone training course or can be incorporated into a "Defensive Driving" course.

The video was produced in response to an increasing number of accidents on national forest roads. Because our work force continually changes, many new employees are inexperienced at driving on mountain roads and may not be familiar with the hazards that exist. Experienced Forest Service drivers speak in "real-world" terms in the video about driving successfully on mountain roads and recognizing the limitations of the driver and the vehicle. The video emphasizes the benefit to drivers when they slow down on steep roads to retain control of their vehicles and avoid accidents.

A second video is planned that will be particularly aimed at nonfire personnel such as bus drivers, caterers, and National Guard drivers who play an important part in our large fire suppression effort every year. Its focus is driving during wildfires. It will be available for the spring 1999 training period.

To receive a free copy of "Driving Mountain Roads—Slowing Down," send a fax to MTDC publications at 406-329-3719, or via e-mail, contact them at (pubs/wo_mtdc@fs.fed.us). ■

Dick Mangan is the program leader for Fire & Aviation, USDA Forest Service, Missoula Technology and Development Center, Missoula, MT.

A New and Efficient Method To Store Fire Records

Tom French

Do you have difficulty storing boxes and boxes of incident records? Have you ever had to search through years of such records to find a firefighter's time report, a fire perimeter map, or to gather information for a Freedom of Information Act (FOIA) request? The Payette National Forest did.

After the fire season of 1994, our forest generated over 250 boxes (about 1,000 pages in each) of fire records. Storage of this many records and searching through them to meet requests was not only difficult, but extremely time consuming. We knew there must be a more efficient way.

Finding a Solution

We looked into placing our records on microfilm, but when we learned the process would cost $9,000, we quickly discarded that idea.

Then we did some research about the use of compact discs (CD's) for record storage. Subsequently in 1995, we purchased a recordable compact disk drive (Pinnacle RCD-1000*), a scanner with an automatic document feeder (HP 3c), and supporting software—Caere OmniPage Pro and Adaptic Easy CD Pro. The total cost of this hardware and software in 1995 was about $3,000. By 1997, many other companies offered similar technology at half the cost.

> Fast, efficient, and easy-to-use compact disk software eases the burden of storing incident records.

Processing the Records

Our first step in storing the records was to categorize them into 1) operations, 2) plans, 3) finance, or 4) logistics; we discarded all duplicate records. Using this Incident Command System (ICS), we then scanned them in Omnipage Pro. Placing 50 pages of records at a time on the automatic document feeder, we scanned all of our 1996 fire records (11 boxes or 11,000 pages) into the computer. This process took about 4 seconds per page. Using Easy CD Pro., we "dumped" them onto one 650-megabyte/74 minute recordable CD. (Recordable CD's currently cost about $3.00.)

We learned that once the compact disk is created, no one can edit or change the incident records; they are an exact image of what was scanned in. If anyone needs information for 1996 fires, we know all we need to do is sit at our work station and use a CD ROM to

In 1994, the Payette National Forest produced 250 boxes of incident records and found that storing and searching through them was both time consuming and difficult. Photo: Tom French, USDA Forest Service, Payette National Forest, 1997.

Tom French is the manager of the Fire Cache for the USDA Forest Service, Payette National Forest, McCall, ID.

**The use of corporation names and/or their products is for the information and convenience of readers and should not be misconstrued as an official endorsement by the U.S. Department of Agriculture or the Forest Service.*

After the 1996 fire season, the Payette National Forest stored 11 boxes of fire records (about 11,000 pages) on this 650 megabyte/74 minute recordable CD. Photo: Tom French, USDA Forest Service, Payette National Forest, 1997.

The computer work station that makes storing fire records more efficient—in the center is the computer with the internal recordable CD drive; to the right is the HP 3c scanner and on the left is the printer. Photo: Tom French, USDA Forest Service, Payette National Forest, 1997.

search for or print any map or fire record we have scanned in.

Projected Future Use

I am the first to acknowledge that I am not a computer expert. Yet, I expect that soon we will be able to initiate a similar process during a wildland fire. After the incident is over, we will be able to present the final fire records package to the forest on one or more compact disks—depending upon how many records that incident generated.

For more information call Tom French at 208-634-0429, e-mail him at /s=t.french/ou1=r04f12a@mhs-fswa.attmail.com, or write him at Box 1026, McCall, ID 83638. ■

Florida's Governor Declares Prescribed Fire Awareness Week

Joseph P. Ferguson

Governor Lawton Chiles and his State of Florida Cabinet took a break from normal business on March 11, 1997, to sign a resolution declaring the second week of March each year as Florida Prescribed Fire Awareness Week. In a ceremony held at the capitol, Governor Chiles and his six Cabinet members presented the signed resolution to Lane Green of Tall Timbers Research Station, who received the resolution on behalf of the North Florida Prescribed Fire Council. A number of State and Federal land management agencies, regulatory agencies, conservation groups, timber companies, consultants, and other prescribed fire supporters were on hand for the signing ceremony.

The text of the resolution reads:

"WHEREAS, the Florida Legislature passed the Prescribed Burning Act in 1990; and

WHEREAS, Prescribed Fire is the most important tool for the management of Florida's public and private natural lands and is critical to the restoration and maintenance of the ecological integrity of Florida's uplands and wetlands; and

WHEREAS, Prescribed Fire is the most effective and least expensive protection against wildfires through the elimination of hazardous fuels; and

Joe Ferguson is a fire management officer for the USDA Forest Service, National Forests in Florida, Tallahassee, FL.

> To remind Floridians annually of the importance of the wise use of prescribed fire in maintaining the many fire-dependent ecosystems in their State, Governor Chiles designated the second week of March as Prescribed Fire Awareness Week.

WHEREAS, over five million acres [2 million ha] of conservation lands and grazing lands are Prescribed Burned in Florida; and

WHEREAS, county commissions throughout the State of Florida are passing resolutions in support of Prescribed Burning; and

WHEREAS, Florida provides the highest levels of Prescribed Fire training, planning and preparation in the Nation and leads the Nation in the number of acres that are Prescribed Burned annually.

NOW, THEREFORE, BE IT RESOLVED that the Governor and Cabinet of the State of Florida do hereby designate the second week of March each year as

Prescribed Fire Awareness Week

in the State of Florida and congratulate those land managers who protect and maintain Florida's natural heritage for present and future generations.

IN TESTIMONY WHEREOF, the Governor and Cabinet of the State of Florida have hereunto subscribed their names and have caused the Official Seal of the State of Florida to be hereunto affixed in the City of Tallahassee on this 11th day of March, 1997."

The resolution was the brainchild of the North Florida Prescribed Fire Council and was initiated as a method to remind Floridians annually of the importance of the wise use of prescribed fire in maintaining the many fire-dependent ecosystems in their State. The council is a coalition of prescribed fire practitioners and supporters from dozens of agencies and groups around north Florida. The North Florida Council, one of three such councils in the State, began developing the support for such a resolution in January of 1996. Bob Crawford, commissioner of Agriculture and Consumer Services for the State of Florida, introduced the resolution that was unanimously approved.

Governor Chiles and his Cabinet present the Prescribed Fire Resolution to representatives of several groups supporting prescribed fire. From left to right, Bob Milligan, comptroller; Sandra Mortham, secretary of state; Bob Crawford, commissioner of agriculture; Governor Lawton Chiles; Bob Butterworth, attorney general; Bill Nelson, treasurer; Frank Brogan, commissioner of education; Lane Green, executive director, Tall Timbers Research Station; Earl Peterson, director, Division of Forestry; Doug Barr, executive director, Northwest Florida Water Management District; Virginia Weatherall, secretary of the Department of Environmental Protection; Alan Egbert, director, Florida Game and Freshwater Fish Commission; Guerry Doolittle, Champion International; and Karl Siderits, forest supervisor, National Forests in Florida. Photo: Bill Simpson, Florida Department of Agriculture and Consumer Services, Tallahassee, FL, 1997.

After the signing ceremony, legislators, agency heads, conservation leaders, the media, and other visitors were invited to a reception with a panoramic view on the capitol building's 22nd floor. While enjoying refreshments and viewing educational displays on prescribed fire, those at the reception were able to observe the smoke column from a prescribed burn on the nearby Apalachicola National Forest.

Prescribed burners from the USDA Forest Service, USDI Fish and Wildlife Service, Florida Division of Forestry, and The Nature Conservancy (in complete fire gear) hand-delivered "reminder" invitations to all 160 State legislators just prior to the reception. They then attended the reception to answer questions from the many interested visitors. Other exhibitors and participants represented Eglin Air Force Base, USDI National Park Service, Florida Game and Freshwater Fish Commission, Florida Department of Environmental Protection, Florida Department of Transportation, Florida State Parks, Tall Timbers Research Station, and St. Johns River Water Management District.

The second week in March was selected because of the large volume of prescribed fire conducted statewide during that time. Those involved hope this awareness week and other annual activities associated with it will help Florida's ever-growing population understand the need for regular uses of prescribed fire as a part of the management of the State's varied ecosystems. ■

"On the Fire Line" Wins 1997 International Film Award

Amy Susan Buckler

The USDA Forest Service has received a top award for its dramatic film "On the Fire Line: A Special Alert from the USDA Forest Service and Your State Forester." It was the only film in its category to receive the 1997 Silver Screen Award for outstanding creativity and effective delivery of its message. Paul Frey, president, and Bill Imbergamo, executive director, National Association of State Foresters, accepted the award plaque on behalf of the Forest Service at the U.S. International Film and Video Festival in Chicago, IL, in June 1997. In producing the film, The Advertising Council built on the long and successful Smokey Bear campaign. "On the Fire Line" delivers an urgent message to the American public: If we want to protect our homes and preserve ecological integrity, we must unite now to make our forests and rangelands healthier and safer from wildfires.

The film has three segments: 1) a dramatization of the nationwide need to reduce wildland fuels, 2) a view of the challenges that wildland firefighters face in America's wildland-urban interface, and 3) scenes of fighting fire with fire—using prescribed burning to balance the needs of the public with the needs of the land. Throughout the film, forest managers, ecologists, fire scientists, and firefighters talk about what we all must do to ensure the proper management of our wildlands.

Fire and Aviation Director Mary Jo Lavin and Chief Mike Dombeck of the Forest Service hold the 1997 Silver Screen Award presented for the film "On The Fire Line." National Fire Prevention Officer Billy J. Terry and former Deputy Chief of State and Private Forestry Joan M. Comanor are also pictured. Photo: Karl Perry, USDA Forest Service, Washington, DC, 1997.

Elsie Cunningham, a recent USDA Forest Service retiree who was the first to suggest that the film be created, has said, "If the forests are to survive into the future for many generations, then people are going to have to be responsible for taking care of them, and part of that responsibility involves the use of fire." The film urges viewers to realize their personal role in responding to the national wildfire emergency.

"On the Fire Line" has already begun to reach the general public. At least 59 of the 140 commercial television markets have already shown the film or will do so soon. The Learning Channel has it under contract until the year 2001.

After May 1998, Federal and State agencies may obtain tapes for their own use. For more information, write National Fire Prevention Officer Billy Terry, USDA Forest Service, Fire and Aviation Management, P.O. Box 96090, Washington, DC 20090-6090; or telephone him at 202-205-1503. ■

Amy Buckler was the assistant editor and intern for Fire Management Notes *from August through December of 1997. She was a volunteer for the USDA Forest Service, North Central Forest Experiment Station, East Lansing, MI.*

Florida Modifies FEPP To Support Emergency Fire Responses

George L. Cooper

Recently the Florida Division of Forestry's Forest Protection Bureau, Fire Resource Section, applied for and was awarded a grant from the State of Florida Department of Community Affairs to convert Federal Excess Personal Property (FEPP) for use by fire and emergency services personnel. Mechanics modified four 400-gallon (1,500-l) water buffalo trailers to turn them into portable lavatory units. Each of four Mobile Kitchen Strike Teams positioned in Florida for dispatch to fire emergencies will have one of the lavatory units. The strike teams can travel to and set up anywhere in Florida in 15 hours. "Setup" is generally regarded as ready to feed up to 200 people.

Modifications were accomplished at the Division of Forestry Fabrication Shop in Lake City, FL, and included installation of the following items:

- Water pressure tank and gauge
- Electric water pump and switch
- Hot water heater (electric, 10-gallon (38-l) recreational vehicle)
- Four stainless steel sinks
- Four automatic shut-off faucets
- Two soap dispensers
- Two paper towel dispensers
- Two aluminum countertops
- Two storage cabinets
- Four stainless steel adjustable mirrors
- Two mercury vapor lights
- Surge hitch and landing gear
- 50-foot (15-m) power cable
- Generator (4,000 watt) with canvas cover
- 525-gallon (1,987-l) gray water bladder

The cost of the modifications to the four water trailers, including labor and all incidentals, was less than $25,000. Simulated utilization has proven that the portable lavatory units will be a valuable addition to the logistical complement of equipment deployed at emergency fire scenes.

Readers wishing to have more information about the modification of this FEPP should contact George Cooper, 3125 Conner Blvd., Tallahassee, FL, 32399-1650, telephone 904-488-6111, FAX 904-488-4445. ■

A 400-gallon (1,500-l), fully self-contained portable lavatory unit that will provide hot or cold running water for firefighters and emergency service personnel day or night.

George Cooper is the fire resource manager for the Florida Division of Forestry's Forest Protection Bureau, Tallahassee, FL.

Byron Bonney Named First "FFMO of the Year"

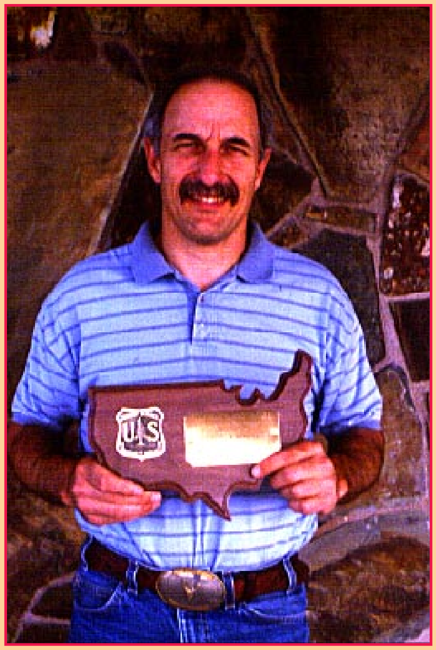
Amy Susan Buckler

Byron J. Bonney, the fire staff officer for the Nez Perce and Clearwater National Forests in Idaho, received the first national "Forest Fire Management Officer (FFMO) of the Year" award presented by the USDA Forest Service. Associate Deputy Chief William McCleese made the presentation to Bonney on May 1, 1997, at what was also a "first" for the agency—the National Forest Fire Management Officers' Conference in Albuquerque, NM.

Bonney's colleagues in the Northern Region originally nominated him for the award. After he was named the regional winner, his nomination was forwarded to the national competition to be judged by the conference committee. Bonney was selected from among eight other fire management officers from throughout the country.

According to Jerry Williams, director of Fire, Aviation, and Air for the agency's Northern Region, the award is given in recognition of an employee who has personal and professional attributes that exemplify the highest standards of a forest fire management officer. "I cannot tell you how proud the entire Northern Region fire management group feels," Williams wrote in a message to employees, "Byron's selection was from among the best in the country."

Amy Buckler was the assistant editor and intern for Fire Management Notes *from August through December of 1997. She was a volunteer for the USDA Forest Service, North Central Forest Experiment Station, East Lansing, MI.*



Byron Bonney displays the plaque he received after being selected "Forest Fire Management Officer of the Year" for his exceptional qualities as fire staff officer for the Nez Perce and Clearwater National Forests in Idaho. Photo: Elayne Murphy, USDA Forest Service, Nez Perce National Forest, Grangeville, ID, 1997.

Qualifications and characteristics considered in the nomination and selection process included demonstration of commitment and dedication in conjunction with professional and technical expertise in overseeing a wide spectrum of activities in wildland fire management. At the field level, the FFMO had to have implemented activities associated with wildland fire management such as FIRE 21, principles of safety, the role of fire in ecosystems, wildland-urban interface initiatives, interagency cooperation, and accountability.

Forest Supervisors Coy Jemmett from the Nez Perce National Forest and Jim Caswell from the Clearwater National Forest agree that Bonney is a credit to the agency and described his technical expertise and ability to work with people as exceptional. One of Bonney's challenges has been to combine fire organizations on the two forests.

Bonney also assisted Clearwater County disaster relief officials during the floods of 1996 when he provided expertise to help them organize their efforts using the Incident Command System. Currently, he is working on a multiforest effort to use prescribed burning as one method to restore ecosystems in the Salmon River Canyon.

In response to his award, Bonney praised his peers: "The people I work with make me look good," he stated. "I also think this is a tribute to the two forests and other people who work here. Nobody does anything apart from the others they work with. Fire management is a team effort and always will be."

Regional representatives of the Forest Service will inform employees about the nomination process and due date for the second national FFMO award. The 1998 Forest Service regional representatives are as follows: Peggy Polichio, Region 1; Scott Steinberg, Region 2; Gary Benavidez, Region 3; Wade Burleson, Region 4; Thom Myall, Region 5; Susan Vap, Region 6; Mike Maguire, Region 8; Thomas Brady, Region 9; Miller Ross, Region 10. ■

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